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(54) **DRIVE MOTOR COOLED BY HEAT EXCHANGE WITH COOLANT AND ECO-FRIENDLY VEHICLE USING THE SAME**

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See application file for complete search history.

(71) Applicants: **HYUNDAI MOTOR COMPANY**, Seoul (KR); **KIA MOTORS CORPORATION**, Seoul (KR)

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(72) Inventors: **Jung-Woo Lee**, Hwaseong-si (KR); **Dong-Yeon Han**, Seoul (KR)

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(73) Assignees: **Hyundai Motor Company**, Seoul (KR); **Kia Motors Corporation**, Seoul (KR)

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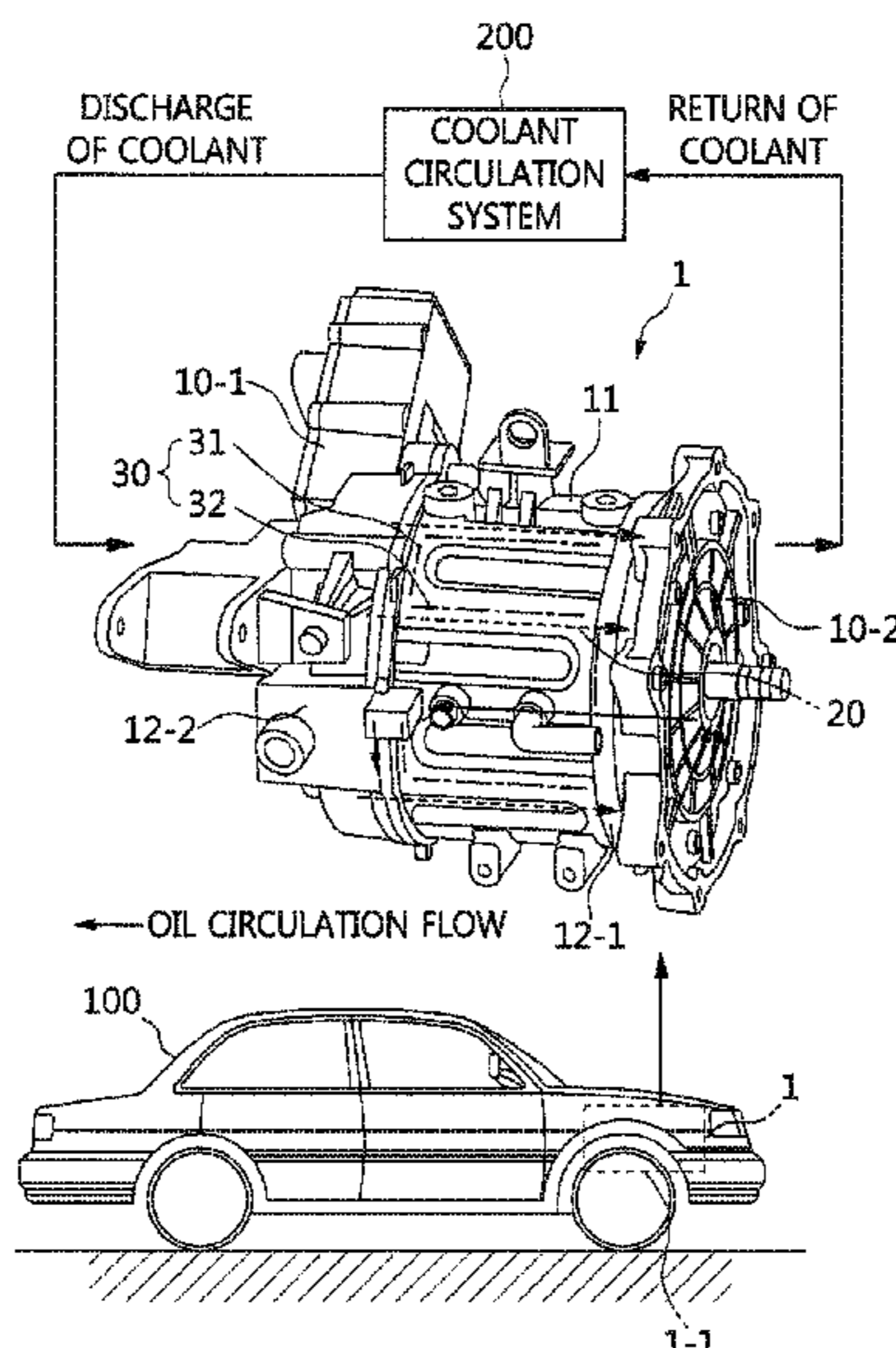
*Primary Examiner* — Yuriy Semenenko  
(74) *Attorney, Agent, or Firm* — Morgan, Lewis & Bockius LLP

(51) **Int. Cl.**  
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(57) **ABSTRACT**  
A drive motor includes a coolant channel in which coolant is circulated around a motor housing surrounding the stator, and an oil path in which the temperature of oil decreases by heat exchange between the oil and the coolant in a motor internal space defined by a motor cover and a reducer cover that are coupled to the respective left and right sides of the motor housing.

(52) **U.S. Cl.**  
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**15 Claims, 4 Drawing Sheets**



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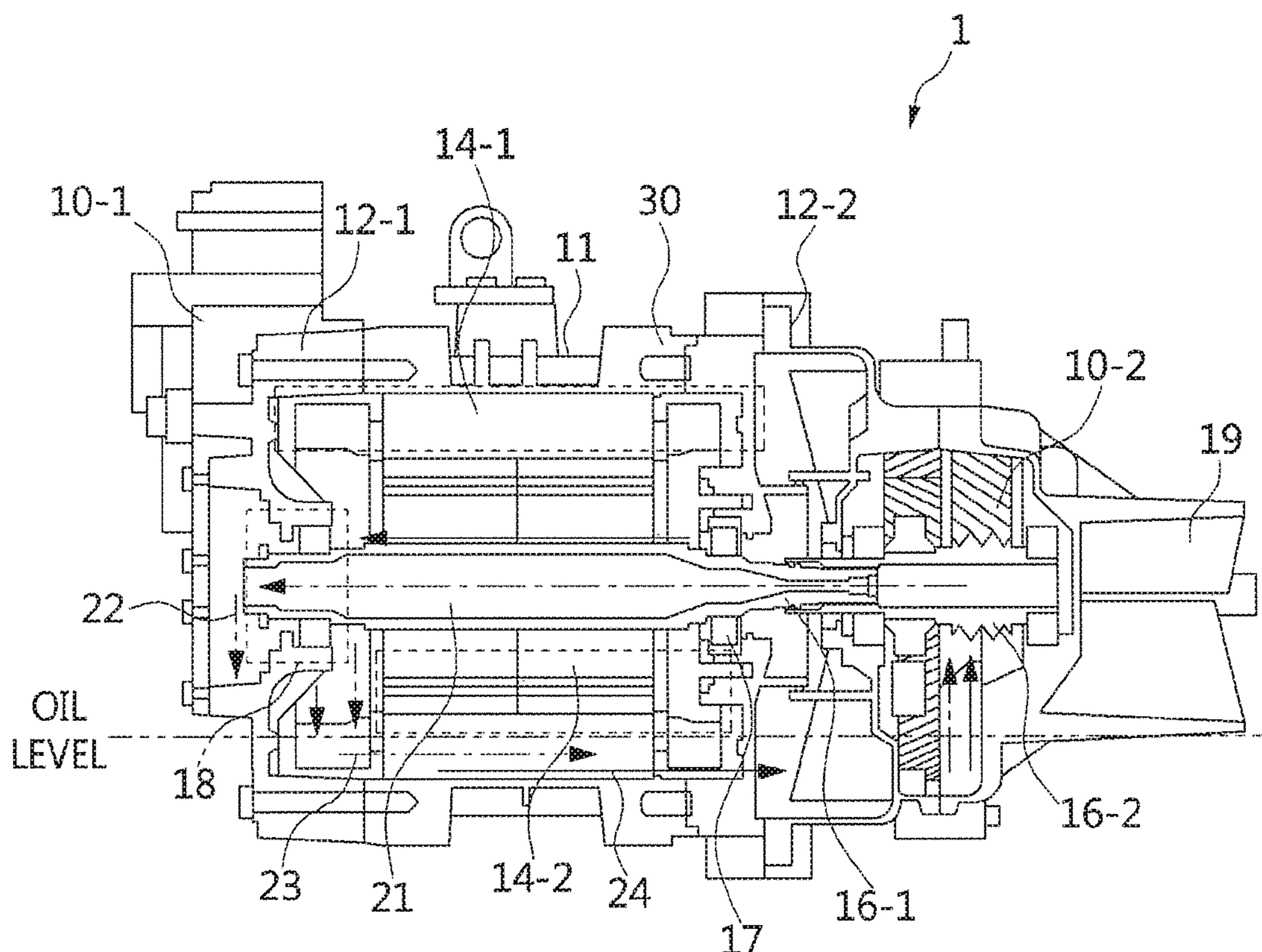
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 FLOW OF OIL (MOTOR + REDUCER)  
 (WITH PASSING THROUGH SHAFT)
  - 
 PART FOR INTENSIVE COOLING
  - 
 FLOW OF OIL (MOTOR + REDUCER)  
 (WITHOUT PASSING THROUGH SHAFT)
- 20: 21, 22, 23, 24

FIG. 1



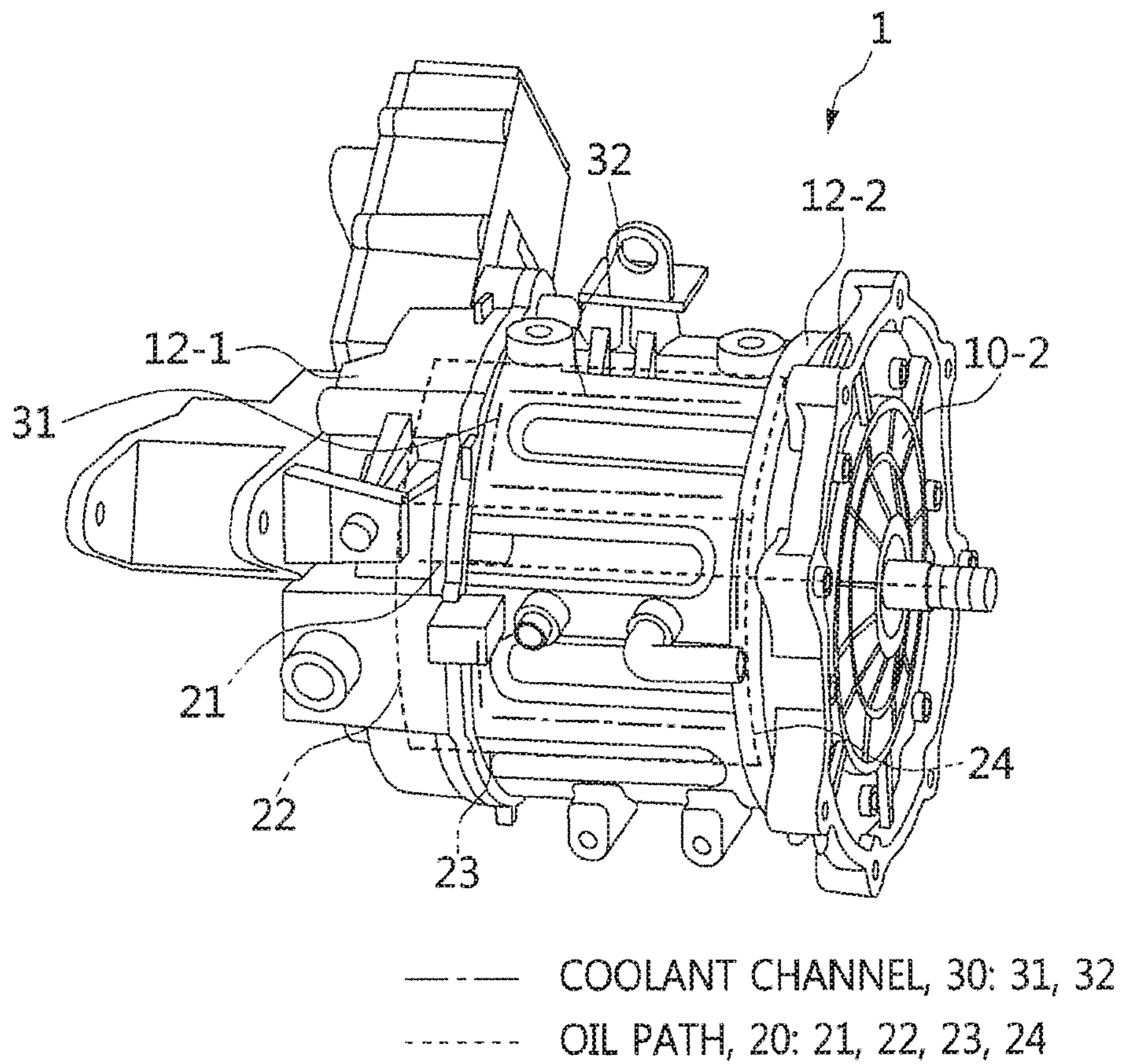


FIG. 2

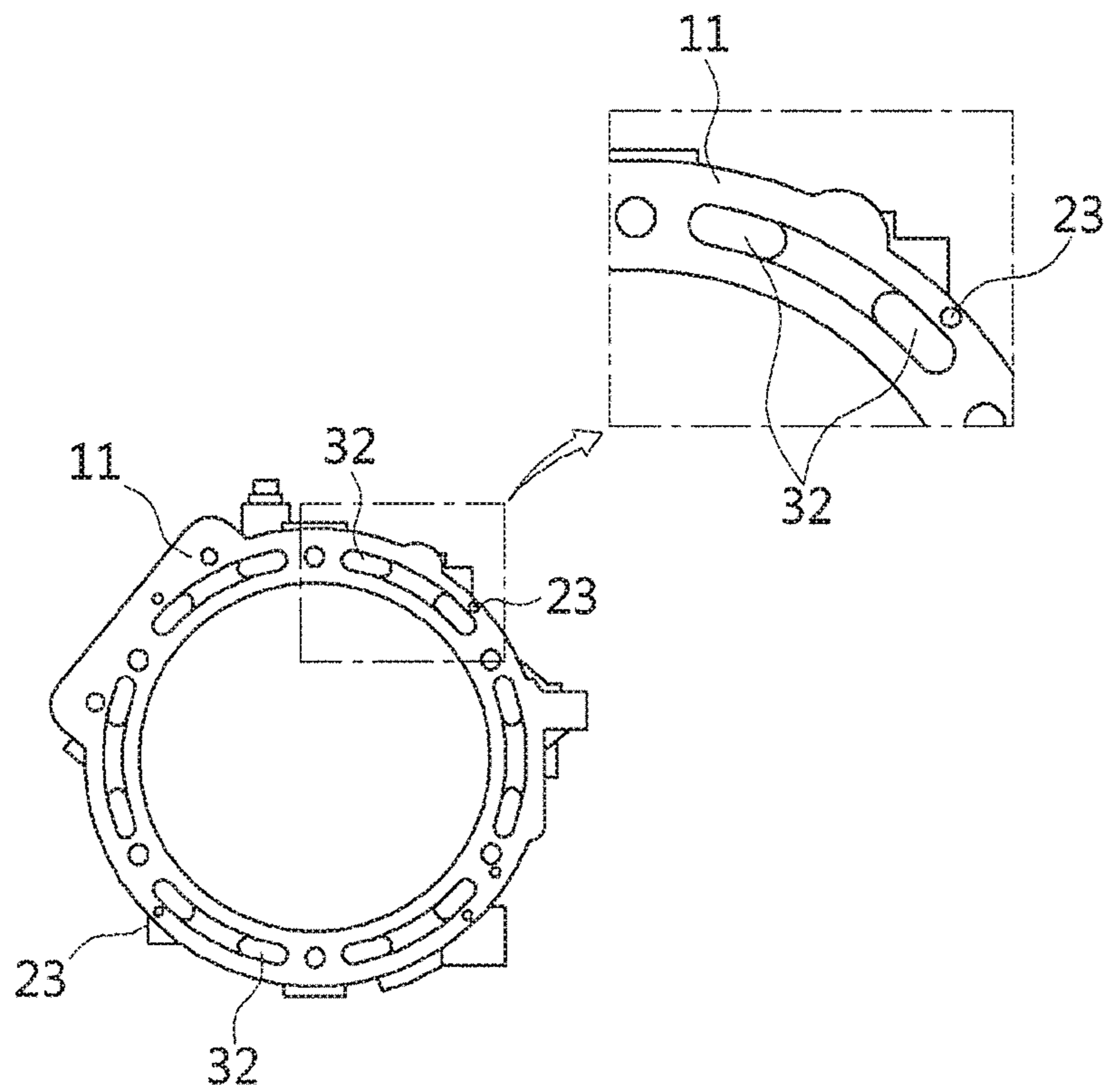


FIG. 3

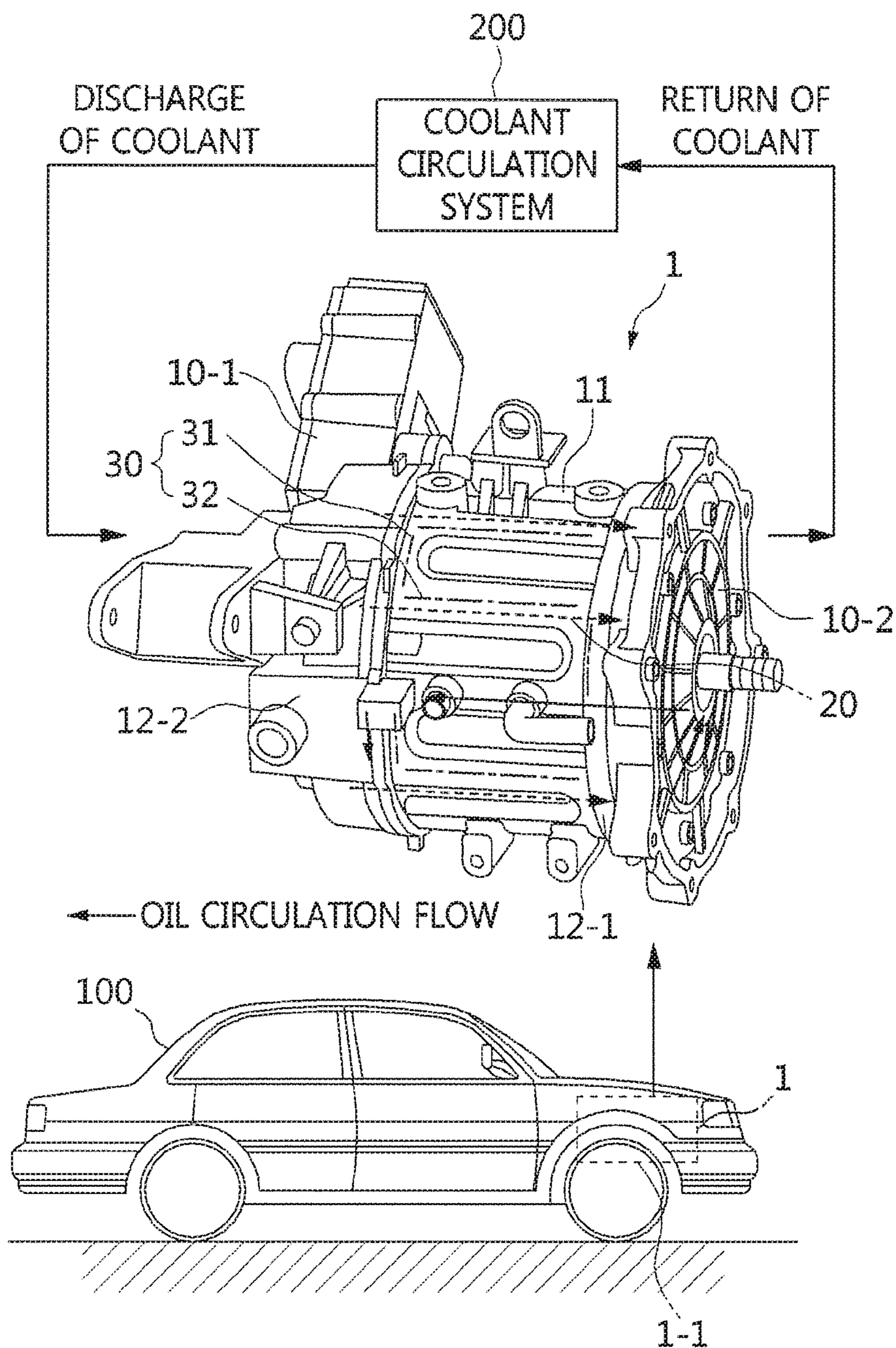


FIG. 4



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**DRIVE MOTOR COOLED BY HEAT  
EXCHANGE WITH COOLANT AND  
ECO-FRIENDLY VEHICLE USING THE  
SAME**

CROSS-REFERENCE TO RELATED  
APPLICATIONS

This application claims the benefit of priority to Korean Patent Application No. 10-2016-0172402, filed on Dec. 16, 2016, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates to a drive motor, and particularly, to an eco-friendly vehicle using a drive motor with improved cooling performance in such a manner that oil is cooled by heat exchange with coolant.

BACKGROUND

In general, drive motors for eco-friendly vehicles are used to implement a traveling mode in which EVs (Electric Vehicles) are driven by motors alone and a traveling mode in which HEVs (Hybrid Electric Vehicles) are driven by combination of motors and engines.

These eco-friendly vehicles are hybrid vehicles, and includes EVs (Electric Vehicles), HEVs (Hybrid Electric Vehicles), PHEVs (Plug-in Hybrid Electric Vehicles), FCEVs (Fuel Cell Electric Vehicles), MHEVs (Mild Hybrid Electric Vehicles), etc.

Such a drive motor includes a stator around which a coil is wound and which is coupled in a motor housing, and a rotor that is disposed in the stator with a predetermined gap interposed therebetween. The drive motor is provided with a cooling structure that cools heat generated by the current applied to the coil and the eddy current due to counter electromotive force.

This cooling structure uses indirect and direct cooling methods that are classified according to the method of cooling main heating parts and parts required for intensive cooling, such as a stator, a bearing, and a magnet of a drive motor.

For example, the indirect cooling method is a method of circulating coolant to a stator, a bearing, and a magnet of a drive motor to indirectly cool the inside of the drive motor. The indirect cooling method enables the cooling efficiency of the stator to be enhanced while enabling the drive motor to have a simple structure in which a coolant channel in a motor housing is used

For example, the direct cooling method is a method of circulating oil within a drive motor and a reducer, to main heating parts and parts required for cooling to directly cool the inside of the drive motor. The direct cooling method enables the cooling efficiency of a bearing and a magnet to be enhanced by a coolant channel formed in the drive motor while enabling a stator to be cooled by forming an oil path in the drive motor.

Accordingly, in the eco-friendly vehicles, it is possible to prevent damage to the drive motor due to deterioration during driving of the drive motor and maintain the performance of the drive motor by applying one or both of the indirect and direct cooling methods to the drive motor.

However, among the part required for intensive cooling, it is difficult for the indirect cooling method to secure the cooling performance of the bearing and the magnet com-

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pared to the stator. It is advantageous for the direct cooling method to secure the cooling performance of the stator, the bearing, and the magnet, but it is necessary to sufficiently secure a flow rate of oil.

Therefore, a separate cooling system has to be provided to the drive motor to which the combination of the indirect and direct cooling methods is applied.

For example, an HEV vehicle, which uses an engine and a motor together, requires an ATF (Auto Transmission Fluid) motor circulation system to supply ATF to the motor. For another example, an EV vehicle, which uses only a motor, requires a cooling system including an oil cooler to cool oil in the motor and a reducer.

For this reason, the application of the drive motor, to which the combination of the indirect and direct cooling methods is applied, to the HEV or EV vehicle causes an increase in cost due to the additional system, which may lead to a decrease in the price competitiveness of the eco-friendly vehicle.

SUMMARY

An embodiment of the present disclosure is directed to a drive motor cooled by heat exchange with coolant, which is capable of having improved cooling performance without using an oil cooler by lowering a temperature of oil by heat exchange between oil circulated in the motor for direct cooling and coolant circulated in a motor housing for indirect cooling, and particularly, which is capable of having high speed and enhanced durability by applying an oil-lubricated bearing, having a higher allowable speed than a dry bearing, to the drive motor by virtue of the improved cooling performance, and an eco-friendly vehicle using the same.

Other objects and advantages of the present disclosure can be understood by the following description, and become apparent with reference to the embodiments of the present disclosure. Also, it is obvious to those skilled in the art to which the present disclosure pertains that the objects and advantages of the present disclosure can be realized by the means as claimed and combinations thereof.

In accordance with an embodiment of the present disclosure, a drive motor includes: a coolant channel in which coolant circulates around a stator supplied with a current; and an oil path in which a temperature of oil decreases by heat exchange between the oil and the coolant while the oil passes around the coolant channel.

The stator may be covered by a motor housing, a motor cover may be coupled to one side of the motor housing, and a reducer cover is coupled to the other side of the motor housing. The coolant channel may include vertical channels formed along a circumference of the motor housing and horizontal channels formed in a longitudinal direction of the motor housing, wherein the horizontal channels may be connected to both ends of an associated one of the vertical channels. The oil path may be formed by the motor cover, the reducer cover, and the motor housing.

The oil path may include a shaft path, a motor cover path, a motor housing path, and a reducer cover path, the shaft path may be formed in the motor shaft, the motor cover path may be formed in the motor cover, the motor housing path may be formed in the motor housing so as to be disposed adjacent to the coolant channel, and the reducer cover path may be formed in the reducer cover.

The stator may surround a magnet coupled to the motor shaft. The motor shaft may be supported by a motor front end bearing as an oil-lubricated bearing and a motor rear end



bearing, and may be connected to a hollow reducer shaft in which the oil flows, the reducer shaft constituting a reducer filled with the oil.

In accordance with another embodiment of the present disclosure, an eco-friendly vehicle includes a drive motor including a hollow motor shaft coupled to a magnet surrounded by a stator supplied with a current so that both portions of the motor shaft are supported by oil-lubricated bearings, a coolant channel in which coolant circulates around a motor housing surrounding the stator, and an oil path in which a temperature of oil decreases by heat exchange between the oil and the coolant in a motor internal space defined by a motor cover and a reducer cover that are coupled to respective left and right sides of the motor housing, and a coolant circulation system configured to circulate the coolant by the drive motor.

The drive motor may be filled with the oil circulated inside the drive motor for cooling action, and the oil may exchange heat with the coolant so that the temperature of the oil is lowered.

The coolant circulation system may be connected to the motor housing by a coolant line to circulate the coolant.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view illustrating a drive motor cooled by heat exchange with coolant through an oil path and a coolant channel according to an embodiment of the present disclosure.

FIG. 2 is a view illustrating an example of the layout of the oil path and the coolant channel applied to the drive motor according to the embodiment of the present disclosure.

FIG. 3 is a view illustrating an example of the oil path and the coolant channel formed in a motor housing according to the embodiment of the present disclosure.

FIG. 4 is a view illustrating a state in which oil flows in an oil path while being cooled by heat exchange with coolant flowing in a coolant channel in a drive motor applied to an eco-friendly vehicle according another embodiment of the present disclosure.

#### DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

Exemplary embodiments of the present disclosure will be described below in more detail with reference to the accompanying drawings. The present disclosure may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the present disclosure to those skilled in the art. Throughout the disclosure, like reference numerals refer to like parts throughout the various figures and embodiments of the present disclosure.

Referring to FIG. 1, a drive motor 1 includes a motor body 10-1 and a reducer 10-2.

The motor body 10-1 includes a motor component part that has a motor shaft 16-1 and generates power, and a cooling component part that cools motor components. A portion of the internal space of the motor body 10-1 is filled with oil 19 for friction reducing and cooling action, and the oil is circulated therein. The reducer 10-2 includes a reducer shaft 16-2 that is rotatably connected to the motor shaft 16-1, and a plurality of gears for deceleration and an increase in torque. A portion of the internal space of the reducer 10-2 is

filled with the oil 19 for friction reducing and cooling action, and the oil is circulated to the motor body 10-1.

For example, the oil 19 is accommodated beneath the motor shaft 16-1 in which the motor body 10-1 is horizontally placed. Therefore, the oil 19 wets a portion of a stator 14-1 in the internal space of the motor body 10-1, and an inner circulation flow is formed in which the oil passes through an oil path 20 by centrifugal force generated by rotation of a magnet 14-2 and the motor shaft 16-1.

Accordingly, when the drive motor 1 is driven, the rotational force of the motor body 10-1 is transmitted to the reducer 10-2 through the motor shaft 16-1 and the reducer shaft 16-2 by connecting the motor shaft 16-1 of the motor body 10-1 to the reducer shaft 16-2 of the reducer 10-2, so that power is output from the reducer 10-2 to a reducer output shaft (not shown).

Specifically, the cooling component part includes an oil path 20 through which oil is circulated in the motor, and a coolant channel 30 through which coolant is circulated on the surface of the motor. For example, the oil path 20 consists of a shaft path 21, a motor cover path 22, a motor housing path 23, and a reducer cover path 24, and forms a flow in which oil passes through a shaft.

However, the oil path 20 may consist of the motor cover path 22, the motor housing path 23, and the reducer cover path 24, and may form a flow in which oil passes through no shaft whereby oil does not pass through the shaft path 21. The flow in which oil passes through no shaft is an inner circulation flow in which the oil 19 flows from the motor cover path 22 through the motor housing path 23 to the reducer cover path 24 by centrifugal force generated by rotation of the magnet 14-2 and the motor shaft 16-1. Therefore, since the flow in which oil passes through no shaft is similar to the flow in which oil passes through a shaft, except for the shaft path 21, an additional description thereof will be omitted.

The shaft path 21 is formed by the hollow motor shaft 16-1 and the hollow reducer shaft 16-2. In the shaft path 21, one end of the reducer shaft 16-2 is formed as an inlet for introduction of the oil 19, and one end of the motor shaft 16-1, which is not connected to the reducer shaft 16-2, is formed as an outlet for discharge of the oil 19.

The motor cover path 22 is formed in a motor cover 12-1, and the oil 19 discharged from the shaft path 21 flows through the motor cover path 22 to a motor housing 11 having the coolant channel 30 in the rear internal space of the motor cover 12-1. Particularly, the motor cover path 22 is formed by combination of the rear internal space of the motor cover 12-1, in which the oil 19 discharged from the shaft path 21 is collected, and a motor-cover oil path that is defined by the thickness of the motor cover 12-1 so as to lead to the motor housing 11. For example, the motor-cover oil path may be formed of a hole or groove that extends vertically and horizontally. However, when the motor cover 12-1 is formed with a rear internal space that allows the oil 19 to flow to the motor housing 11, the motor-cover oil path may be formed of a rear-inner-space oil path that directly uses the structure of the motor cover 12-1 without using the thickness of the motor cover 12-1.

The motor housing path 23 is formed in the motor housing 11, and the oil 19 discharged from the motor cover path 22 flows through the motor housing path 23 to a reducer cover 12-2 in a state in which the oil is cooled by heat exchange with the coolant in the coolant channel 30. Particularly, the motor housing path 23 is adjacent to the coolant channel 30 in order to increase heat exchange between oil and coolant.



The reducer cover path **24** is formed in the reducer cover **12-2**, and the oil **19** discharged from the motor housing path **23** flows through the motor cover path **24** to the front internal space of the reducer cover **12-2**. Particularly, the reducer cover path **24** is formed by combination of the front internal space of the reducer cover **12-2**, in which the oil **19** discharged from the motor housing path **23** is collected, and a reducer-cover oil path that is dented by the thickness of the reducer cover **12-2** so as to lead to the motor housing **11**. For example, the reducer-cover oil path may be formed of a hole or groove that extends vertically and horizontally. However, when the reducer cover **12-2** is configured such that the oil **19** directly flows to the front internal space of the reducer cover **12-2** without passing through the reducer-cover oil path, the reducer-cover oil path may not be formed.

For example, the coolant channel **30** is formed by the motor housing **11** so as to be adjacent to the motor housing path **23** formed in the motor housing **11**, thereby forming a coolant path in which coolant flows. Particularly, the coolant channel **30** may be formed of a rectilinear or curved groove that has a coolant inlet for introduction of coolant and a coolant outlet for discharge of coolant.

Specifically, the motor component part includes a motor case, a stator **14-1**, a magnet **14-2**, a motor shaft **16-1**, a shaft bearing, and oil **19**.

For example, the motor case includes the motor housing **11**, the motor cover **12-1**, and the reducer cover **12-2**. The motor housing **11** surrounds the motor body **10-1** to block the inside of the motor body **10-1** from the outside, and forms the coolant channel **30** connected to the oil path **20**. The motor cover **12-1** is coupled to one side of the motor housing **11** to form the rear portion of the motor body **10-1**, and forms the oil path **20** connected to the motor housing **11**. The reducer cover **12-2** is coupled to the other side of the motor housing **11** (the opposite portion of the motor cover **12-1**) to form the front portion of the motor body **10-1**. The reducer cover **12-2** is coupled to the reducer **10-2**. Particularly, the motor housing **11**, the motor cover **12-1**, and the reducer cover **12-2** form a sealing structure to prevent the oil **19** therein from leaking. The sealing structure is typically formed using packing or a seal.

For example, the stator **14-1** is formed in the drive motor **1** by winding a coil around a bobbin. The magnet **14-2** is surrounded by the stator **14-1**, and is rotated by electromagnetic force generated by the current supplied to the stator **14-1** to rotate the motor shaft **16-1**. Therefore, the magnet **14-2** is typically coupled to the motor shaft **16-1**.

For example, the motor shaft **16-1** is a hollow shaft for introduction and discharge of the oil **19**, and is axially arranged in the motor body **10-1**. The motor shaft **16-1** generates power of the drive motor **1** by rotating along with the magnet **14-2**. Particularly, the motor shaft **16-1** is connected to the reducer shaft **16-2** to output the power of the drive motor **1** to the reducer **10-2**.

For example, the shaft bearing includes a motor shaft bearing that supports the motor shaft **16-1** and a reducer shaft bearing that supports the reducer shaft **16-2**. The motor shaft bearing includes a motor front end bearing **17** that supports a front end of the motor shaft **16-1** (an end of the motor shaft which is connected to the reducer shaft **16-2**) a motor rear end bearing **18** that supports a rear end of the motor shaft **16-1** (an end of the motor shaft which is not connected to the reducer shaft **16-2**). Particularly, an oil-lubricated bearing is used as the motor front end bearing **17** and the motor rear end bearing **18** by virtue of an improvement in cooling efficiency by the oil path **20**. As a result, the

drive motor **1** has a higher allowable speed than a dry bearing by the oil-lubricated bearing.

For example, the oil **19** is motor oil that is accommodated in the motor body **10-1** and reducer oil that is accommodated in the reducer **10-2**. The oil **19** generates friction reducing and cooling action by circulation of oil in the motor body **10-1** and the reducer **10-2** through the oil path **20**.

FIG. **2** illustrates the layout of the oil path **20** and the coolant channel **30**.

For example, the coolant channel **30** includes vertical channels **31** that are formed along the circumference of the motor housing **11** and horizontal channels **32** that are formed in the longitudinal direction of the motor housing **11**. Particularly, the horizontal channels **32** are respectively connected to both ends of the associated one of the vertical channels **31** (wherein, the horizontal channels are illustrated as if they are separated from each other in FIG. **2** for convenience sake), to form a “ $\square$ ” shape. The horizontal channels forming a “ $\square$ ” shape are continuously arranged along the circumference of the motor housing **11** to continuously form a “ $\square$ ” shape.

For example, the oil path **20** is configured such that the shaft path **21** formed by the motor shaft **16-1** and the reducer shaft **16-2** is axially arranged in the center of the drive motor **1**, the motor cover path **22** and the reducer cover path **24** are formed along the respective circumferences of the motor cover **12-1** and the reducer cover **12-2** to be arranged adjacent to the vertical channels **31**, and the motor housing path **23** is formed in the longitudinal direction of the motor housing **11** to be disposed adjacent to the horizontal channels **32**.

FIG. **3** illustrates the relationship between the motor housing path **23** of the oil path **20** and the horizontal channels **32** of the coolant channel **30**. As illustrated in FIG. **3**, the motor housing path **23** has a circular shape whereas each of the horizontal channels **32** has an elongated hole.

Particularly, the motor housing path **23** penetrates the motor housing **11** so as to be disposed above the horizontal channels **32**. However, the motor housing path **23** may be disposed beneath the horizontal channels **32**. In addition, the motor housing path **23** may be formed in one of two adjacent horizontal channels **32** or in all horizontal channels **32**. In addition, the motor housing path **23** may consist of a plurality of motor housing paths arranged along the width of one horizontal channel **32** by adjusting the diameter thereof.

FIG. **4** illustrates an example of an eco-friendly vehicle **100** such as an EV vehicle which includes a drive motor **1**, a power transmission device **1-1**, and a coolant circulation system **200**.

Specifically, the drive motor **1** is similar to the drive motor cooled by heat exchange with coolant which is described in FIGS. **1** and **2**. Therefore, the drive motor **1** includes the coolant channel **30** having a continuous “ $\square$ ” shape, and the oil path **20** that includes the shaft path **21**, the motor cover path **22**, the motor housing path **23**, and the reducer cover path **24**.

Specifically, the power transmission device **1-1** transmits the power of the drive motor **1** to vehicle wheels.

Specifically, the coolant circulation system **200** includes a coolant reservoir that is filled with coolant and a pump that pumps coolant, which are not illustrated. The coolant circulation system **200** is connected to the drive motor **1** by coolant lines that are respectively connected to the inlet and the outlet of the coolant channel **30**.



Accordingly, when the drive motor **1** is driven, the oil **19** is circulated by centrifugal force generated by rotation of the magnet **14-2** and the motor shaft **16-1** and by a variation in pressure therein. The oil **19** is circulated in the oil path **20** while repeatedly passing through the shaft path **21**→the motor cover path **22**→the motor housing path **23**→the reducer cover path **24**→the shaft path **21**. Here, the symbol “→” is a sign indicative of the flow direction of the oil **19**. As a result, the oil **19** uniformly and effectively cools the motor shaft **16-1**, the magnet **14-2**, the motor front end bearing **17**, the stator **14-1**, and the motor rear end bearing **18**.

In addition, when the coolant circulation system **200** is operated, the coolant is circulated to the motor housing **11** through the coolant channel **30**. As a result, the coolant cools the whole stator **14-1** covered by the motor housing **11** while exchanging heat with the oil **19** flowing through the motor housing path **23** in a state in which it is adjacent to the coolant channel **30**. That is, the oil **19**, the temperature of which is increased by heating of the motor, discharged from the motor cover path **22** is cooled by heat exchange with coolant while passing through the motor housing path **23**, and then flows to the reducer cover path **24**. As a result, the stator **14-1** is more effectively cooled by the coolant and the oil **19** having a relatively low temperature.

As described above, the drive motor **1** applied to the eco-friendly vehicle according to the embodiment of the present disclosure includes the hollow motor shaft **16-1** that is coupled to the magnet **14-2** surrounded by the stator **14-1** supplied with a current so that both portions of the shaft are supported by bearings, the coolant channel **30** in which coolant is circulated around the motor housing **11** surrounding the stator **14-1**, and the oil path **20** in which the temperature of oil is lowered by heat exchange between the oil and the coolant in the motor internal space defined by the motor cover **12-1** and the reducer cover **12-2** that are coupled to the respective left and right of the motor housing **11**. Thus, it is possible to improve the cooling performance of the motor without using an oil cooler and particularly to achieve the high speed and the enhanced durability of the motor by applying the oil-lubricated bearing, which has a higher allowable speed than the dry bearing, to the bearing for supporting the motor shaft **16-1** by virtue of the improved cooling performance.

As apparent from the above description, a drive motor according to exemplary embodiments of the present disclosure has the following advantages and effects by application of a cooling structure using heat exchange with coolant.

Firstly, it is possible to obtain a synergy cooling effect even by oil in a motor and a reducer by cooling oil by heat exchange with coolant. Secondly, since only the oil in the motor and the reducer is used, there is no need to supply an ATF for securing a flow rate of oil or there is no need for an oil cooler for cooling oil. Thirdly, since there is no need for using the ATF and for the oil cooler, the structure of a motor cooling system is simplified. Fourthly, since a bearing is more effectively cooled by oil, an oil-lubricated bearing having high cooling performance compared to a dry bearing can be applied to the motor. Fifthly, it is possible to achieve the high speed and the enhanced durability of the motor by application of the oil-lubricated bearing having a higher allowable speed than the dry bearing.

In addition, since there is no need to supply an ATF to an eco-friendly vehicle using the drive motor of the present disclosure together with an engine as a power source, the

structure of the power system can be simplified and the price competitiveness of the eco-friendly vehicle can be significantly increased.

Furthermore, since it is unnecessary to apply the oil cooler for cooling oil to an EV vehicle using the drive motor of the present disclosure as a power source, the structure of the power system can be simplified and the price competitiveness of the eco-friendly vehicle can be significantly increased.

While the present disclosure has been described with respect to the specific embodiments, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A drive motor comprising:
  - a coolant channel in which coolant circulates around a stator having a current; and
  - an oil path in which a temperature of oil decreases by heat exchange between the oil and the coolant while the oil passes around the coolant channel, wherein the coolant channel comprises vertical channels along a circumference of a motor housing and horizontal channels in a longitudinal direction of the motor housing, and the oil path is disposed adjacent to the horizontal channels arranged in the longitudinal direction of the motor housing, wherein the horizontal channels are connected to both ends of an associated one of the vertical channels, and wherein the horizontal channels and the associated one of vertical channels define a “ $\square$ ” shape and are continuously arranged along the circumference of the motor housing in a “ $\square \sqcup$ ” shape.
2. The drive motor of claim 1, wherein the drive motor has a motor internal space which is filled with the oil.
3. The drive motor of claim 1, wherein the stator is covered by the motor housing which includes the coolant channel and the oil path.
4. The drive motor of claim 3, wherein the oil path is adjacent to the coolant channel.
5. The drive motor of claim 3, wherein a motor cover is coupled to one side of the motor housing, a reducer cover is coupled to the other side of the motor housing, and the motor cover and the reducer cover block the motor internal space from outside while defining the oil path together with the motor housing.
6. The drive motor of claim 5, wherein the motor internal space includes the oil path, in which the oil circulates such that the oil discharged from a hollow motor shaft passes through the stator and then flows into the motor shaft, and wherein the temperature of the oil decreases by heat exchange between the oil and the coolant while the oil passes through the stator.
7. The drive motor of claim 5, wherein:
  - the oil path comprises a shaft path, a motor cover path, a motor housing path, and a reducer cover path; and
  - the shaft path is defined in the motor shaft, the motor cover path is defined in the motor cover, the motor housing path is defined in the motor housing to be disposed adjacent to the coolant channel, and the reducer cover path is defined in the reducer cover.
8. The drive motor of claim 1, wherein the stator surrounds a magnet coupled to a motor shaft.



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9. The drive motor of claim 8, wherein the motor shaft is supported by a motor front end bearing and a motor rear end bearing, and the motor front end bearing is an oil-lubricated bearing.

10. The drive motor of claim 8, wherein the motor shaft is connected to a hollow reducer shaft in which the oil flows, and the reducer shaft constitutes a reducer filled with the oil.

11. An eco-friendly vehicle comprising:

a drive motor according to claim 1,

wherein the drive motor further comprises:

a hollow motor shaft coupled to a magnet surrounded by a stator having a current so that both portions of the motor shaft are supported by oil-lubricated bearings; and

a coolant circulation system configured to circulate the coolant by the drive motor,

wherein the coolant circulates around the motor housing surrounding the stator, and

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wherein the oil path is defined in a motor internal space which is defined by a motor cover and a reducer cover that are coupled to respective left and right sides of the motor housing.

12. The eco-friendly vehicle of claim 11, wherein the drive motor is filled with the oil, and the oil exchanges heat with the coolant so that the temperature of the oil decreases.

13. The eco-friendly vehicle of claim 12, wherein the oil circulates inside the drive motor, and the coolant circulates outside the drive motor.

14. The eco-friendly vehicle of claim 11, wherein the coolant circulation system is connected to the drive motor by a coolant line to circulate the coolant.

15. The eco-friendly vehicle of claim 11, wherein the coolant circulation system includes a coolant reservoir and a pump.

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